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PRUNING WHITE PINE

A Literature Review

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PRUNING WHITE PINE

A Literature Review

david t. funk

"A thing is never too often repeated which is never sufficiently learned." — Seneca.

White pine *(Pinus strobus* L.) prunes itself very poorly, even when grown at close spacing. In crowded stands the lower limbs die soon after the crowns close, but the dead limbs don't fall for many years *(17, 23, 26)*[1]. Therefore, the only way to restrict the size of the knotty core of white pine butt logs is to remove the limbs mechanically as early as practical.

Typically, white pine plantings in the Midwest have been left to develop on their own with practically no cultural treatment — at least no pruning (fig. 1). Foresters agree that planted trees on thousands of acres need to be pruned. But since pruning is not common we must assume that many plantation owners are not yet persuaded that it is a sound and profitable practice.

After reviewing the literature, we are convinced that white pine plantations should be pruned except, perhaps, on very poor sites. Apparently, Seneca's maxim holds the answer: The desirability of pruning white pine plantations has not been publicized enough to be accepted. So we present this literature review with the hope that the evidence thus arrayed will help to reemphasize the need for pruning.

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[1]Numbers in parentheses refer to Literature Cited, page 11.

FIGURE 1. — This 50-year-old white pine plantation near Carbondale, Ohio has never been pruned or thinned. Note that dead limbs persist almost to the ground.

WHY PRUNE?

Here are a few of the reasons for pruning mentioned throughout the literature (Cook *(6)* and Smith *(29)* have good discussions):

1. First, of course, pruning improves the quality of logs eventually sawed from the pruned portion of the tree.
2. Pruning also improves bole form.
3. Pruned trees peel more easily for pulp.
4. Pruning forestalls transmission of rot from limbs to the bole.
5. Pruning reduces the possibility of ground fires crowning.
6. Pruning reduces fire hazard by depositing slash at several different times rather than all at once in the harvest operation. Likewise the return of nutrients to the forest soil is more regular.
7. Pruned plantations are easy to work in, i.e. cutting, skidding, and so forth, are easier than in non-pruned plantations.

The possible consequence of *not* pruning is shown in Paul's study of four Wisconsin stands *(23)*. He found that *overgrown dead* white pine branches in the lower 20 feet of the bole persisted for an average of 27 years and a maximum of 73.

HOW TO PRUNE

Tools

Many types of equipment have been used in pruning *(22)* and new ones are constantly being tested in a continual effort to save time and increase efficiency. Pruning with some kind of ax or chisel has been tried repeatedly because of its apparent rapidity, but most authors *(5, 16, 22)* agree that handsaw pruning is safer, perhaps faster, and certainly less damaging to the tree. Hawley and Clapp are very partial to use of a ladder in combination with the handsaw *(16)*, while Mollenhauer advocates the "Tarzan" method in which the pruner, carrying his saw, climbs the tree and then cuts the limbs off as he comes back down *(22)*. Obviously this would not work well on trees that have already been partially pruned. Hawley and Clapp and Mollenhauer agree that the handsaw beats the polesaw, and Ralston also suggested this when he found that polesaw efficiency fell off noticeably with increased height *(25)*. A power pruner that uses a drill bit as a cutting head is a promising recent development.

Techniques

Formerly, some type of stub pruning was popular *(8)*, but more recent research shows the advantage of close pruning. Adams and Schneller recommend wounding of the "shoulder" at the base of the branch *(1)*. Although this method is about 15 percent slower than cutting off the branch outside the base it has the advantage of promoting resin flow and callus formation when live branches are pruned (green pruning). Increased resin flow inhibits insect and fungus attack while rapid callusing means quicker healing. It must be borne in mind, however, that pruning deeper than the base of the branches of an entire whorl can girdle a small tree. Care must also be taken not to tear the bark on the trunk.

Curtis recommends "dry pruning" (removing dead branches) as good conservative practice since these branches are obviously of no further photosynthetic value to the tree *(7)*. Furthermore, if no live tissue is wounded at the base of the branch, there will be little danger of tearing bark on the trunk of the tree. Dry pruning does not cause any resin flow, thereby losing the advantages already mentioned. However, pitch pockets in the resultant lumber are prevented. The whole matter of pitch pockets, black knots, and so forth, is debated throughout the literature. It appears that some sort of structural weakness is created in lumber at the point where a branch was removed from the tree, but small pitch pockets are

probably no more serious that the unavoidable irregularities that develop in growth rings as they grow over the pruning wound.

For quality growth, frequent light prunings are preferred over one heavy one *(19);* Bull even found this method to be cheaper (for longleaf pine [*P. palustris* Mill.]) *(3).* Hawley and Clapp also recommend this method of multi-stage pruning: First, stand on the ground and cut the branches from shoulder height down to the ground; second, cut all branches easily reached from an 8-foot ladder; last, using a 12-foot ladder, prune all branches up to 17 feet *(16).* Engle needed about 7 to 9 minutes to prune red pines (*P. resinosa* Ait.) to 17 feet with a saw and ladder if done all at one time, and 9 to 10 minutes per tree if the pruning was done in three separate operations *(13).* But he still recommends the three-step method even to the extent of suggesting that three crews do the job at the same time.

Bud pruning has been proposed as an inexpensive method to get rid of limbs "before they start" *(14, 24).* But this technique has several disadvantages: Increased susceptibility to weevilling *(11),* sprouting of lateral buds *(11, 24),* and the danger of losing the tree if the tender new leader is damaged. At this time it must be considered a risky business, unlikely to save enough money to make it preferable to branch pruning. A possible substitute would be to snip 1-year-old branches with pruners *(24).* This technique should prevent some lateral bud sprouting, and loss of the leader (now 1 year old) ought to be less likely, too.

WHEN TO PRUNE

Season

Adams and Schneller found in Vermont that white pine healed best if pruned between December and February *(1).* However, Cline and Fletcher felt that when pruning small limbs, season is not important *(5).* Ralston and Lemmien agree that pruning can be done at any time of the year, but point out that a more careful job is necessary during the growing season *(26).* It seems that although mid-winter pruning is the ideal from the silvicultural standpoint, availability of labor and other administrative factors are more important in scheduling the job.

Tree Size

Pruning early, while branches are still small, has proved to be most satisfactory. But many owners have probably delayed pruning because

they assumed that these little limbs might soon die and drop off. However, Paul found that small branches persist on the tree even longer than large ones *(23)*. Apparently this is because the small branches dry out so quickly after dying that fungi cannot multiply in them. Hence pruning branches while they are small should also minimize rot and defect. If pruning is scheduled before the bulk of the branches to be removed reach 2 inches in diameter (or 1 inch, ideally), not much of a fungus problem should arise with either live or dead branches *(4, 5)*.

WHICH TREES TO PRUNE

Obviously the trees that will grow fastest in the future are the ones to prune. Frothingham used crown ratio as a basis for selecting fast-growing trees. He found that the greater the length of live crown (expressed as a percent of the total height), the faster the tree grew in diameter *(15)*. This corroborates Davis's results in Maine *(9)*.

Naturally, the trees selected to be pruned should be the same trees selected as potential crop trees in thinning or release work *(17)*. Sometimes though, in order to take advantage of rapid early diameter growth, pruning may be done before there is any need for thinning. However, Smith recommends waiting until some expression of dominance is apparent before choosing crop trees *(29)*. McCabe and Labisky point out that there is no need to discriminate against otherwise good trees with forked leaders as this can easily be corrected while pruning young white pine *(21)*.

Since pruning is usually done while the trees are comparatively young, some safety factor should be allowed when selecting the crop trees. Lane suggests pruning about 30 percent more trees than are expected to make up the final stand at the end of the rotation *(19)*.

Engle points out that plantation age should also be considered when selecting crop trees. Visibility is poor in most 15-to-20-foot-tall stands because the crowns are usually closed at eye height. Visibility improves as the trees grow older and the limbs die, but delaying pruning until this time naturally leaves a larger knotty core. It is easier to select dominant trees in stands shorter than 15 or 20 feet, but a larger safety factor must be allowed *(13)*. To avoid this problem Williamson suggests pruning all trees except outside rows to a height of at least 6 feet. This would allow more accurate selection of crop trees in the future, reduce fire hazard, and simplify location of marked trees by work crews *(31)*. Runts and culls might just as well be cut as pruned in this first operation.

WHAT TO EXPECT

Growth Response

Assuming first that no growth change could be expected if only dead branches were removed, many foresters have gone one step further and assumed that no effective photosynthetic area would be lost if the completely shaded, live branches were also cut *(16)*. However, this rule-of-thumb would not allow pruning more-or-less-open-grown trees until the trees were so old and the branches so large that it would be completely impractical to remove them. Besides, we naturally want to go just as high as possible without causing any serious growth loss. So, a better rule-of-thumb is that it is reasonably safe to prune up to 25 percent of the total length of the live crown, or up to 50 percent of the total height of the tree *(5)*.

For instance, Barrett and Downs pruned 26 to 35 percent of the live crown of 2-to-7-inch d.b.h. white pines without affecting height growth. The pruning reduced the living crown to an average of 52 percent of the total height of the tree *(2)*. Diameter growth declined slightly but recovered to equal that of check trees in 5 to 8 years *(12)*.

Similarly, Ralston and Lemmien working in Michigan (with red pine) found that on good sites removal of up to 50 percent of live crowns reduced neither height nor diameter growth more than about 10 percent. On poorer sites, growth was more severely retarded by this relatively heavy pruning *(26)*.

Although heavy pruning might reduce growth, it apparently has little effect on crown class. For example, Slabaugh was able to prune up to 50 percent of the total height (of red pine) without causing loss of dominance *(28)*.

Even small trees can be similarly pruned. Logan pruned all but the upper two whorls of white pine seedlings and in 3 years they grew from 3.7 to 6.9 feet tall (the lower whorl was removed each spring). Unpruned trees grew from 3.7 to 6.6 feet in the same time *(20)*.

Several authors report a growth decrease, especially in diameter growth, following pruning of more than half the total height. This result is corroborated by Frothingham's work in the Biltmore plantations in North Carolina. Although his work deals with thinning rather than pruning, he found that regardless of thinning intensity, basal area growth was closely related to length of live crown (within a range of 29 to 55 percent of total height) *(15)*. Apparently white pine trees with less than 50 percent of their height in live crown (whether pruned or not) grow more slowly than those with larger crowns.

Effect on Bole Form

Cline and Fletcher quote some European authors who found bole taper to be reduced following branch pruning *(5)*. Fox gives striking figures to show the improvement in form following bud pruning of white pine: 8 years after pruning the bud-pruned trees had a form quotient of 0.75 while unpruned trees averaged 0.53 *(14)*.

OTHER CONSIDERATIONS

Related Silvicultural Practices

Throughout the literature there is a great deal of emphasis on coordinating thinning with pruning *(4, 5, 16, 29)*. Of course, any practice that speeds up formation of clear wood outside the knotty core is desirable. Thus, thinning and pruning complement one another; each helps justify the other (fig. 2).

Hawley and Clapp mention that pruning previously released trees is good practice — diameter growth should be good and the trees ought to be easy to work on *(17)*. This, of course, implies planting at close spacings for, as Engle points out, wide spacing promotes rapid diameter growth and necessitates early, intensive pruning *(13)*.

FIGURE 2. — A 44-year-old white pine plantation on the Waterloo State Forest, Ohio. Trees in this plantation were pruned to 17 feet at age 19 and to 33 feet when 41 years old. This plantation has also been thinned three times.

At any rate, close spacing should make it possible to delay initial pruning and combine it with the first thinning. Cline and Fletcher claim, moreover, that pruning is cheaper in relatively dense stands because earlier crown closure promotes greater "dead length" and smaller lower limbs *(5)*. These factors combined might make it practicable to prune to a greater height in a dense stand than in an open-grown stand without an adverse effect on growth.

On the other hand, white pine, once pruned, stays pruned; it does not produce epicormic branches regardless of stand spacing or degree of thinning. Furthermore white pine does not self-prune well, no matter how closely spaced; thus it should be feasible to plant white pine at wider spacing than is common with other species. It might even be possible to plant only enough trees for a final crop plus, of course, some additional ones for a safety factor. Such planting would be cheaper than planting at regular spacing and, if the first thinning were postponed, might be especially practical in areas where no market for thinnings (particularly early thinnings) is anticipated.

And the delay in thinning should also help avoid, or at least retard, attack by *Fomes annosus* root rot, which is becoming increasingly serious in the eastern United States, especially in thinned plantations *(30)*.

Obviously, advantages and disadvantages can be cited for either close spacings or wide spacings, and an owner must compromise according to which factors seem to him most important. In the Central States, spacings of 7 by 7 or 8 by 8 feet will result in earlier crown closure and smaller branches; a 9- by 9-foot spacing will reduce planting costs and delay the first thinnings.

Costs and Returns

Two Yale bulletins emphasize the fact that diameter (within reasonable limits) does not need to be considered when deciding when or whether to prune. Of much greater importance are the probable rate of future growth and the length of time remaining before the pruned tree will be harvested. A minimum of 30 years between pruning and harvest is suggested for white pine, with 50 years even more desirable *(17, 18)*. Davis points out that this principle also holds true for ponderosa pine (*P. ponderosa* Laws.); with the uneven-aged stands and longer rotation common to this species it is profitable to prune trees as large as 18 inches d.b.h. *(10)*. He also suggests that a constant diameter growth rate of 1.6 inches or more in 10 years is sufficient to make pruning pay in white pine stands *(9)*.

Although density has not been shown to be an important factor in pruning cost, Campbell insists that it is very important to pruning profit through its effect on growth rate following pruning *(4)*.

Several points are usually brought out in a discussion of pruning costs:

1. Small limbs are easier to prune than big ones.
2. Dead limbs can be sawed through faster than live ones.
3. Pruning time per lineal foot of bole increases directly with tree height.

There are several explanations for this third item. For one, polesaws become more and more unwieldy as additional sections are added *(25)*, and longer ladders are naturally harder to carry and erect. Also, there are likely to be bigger branches and more live branches as pruning proceeds upward into the lower crown *(13, 25)*. Ralston and Lemmien give an example (for red pine) in which it cost more than twice as much per foot to prune between 12.5 and 17.0 feet as it did between 0 and 8.5 feet *(26)*. However, Mollenhauer claims that cost of pruning by the "Tarzan" method does not increase with height except for the additional time needed to prune the larger diameter branches *(22)*. Cline and Fletcher consider 100 linear feet per hour to be a fair rate for saw pruning 2-to-6-inch trees to 16 feet *(5)*.

It is, of course, necessary to do some speculating about future prices before it is possible to calculate any eventual net profit due to pruning. However, Campbell uses what seem to be reasonable assumptions to calculate an average profit of $12.45 per acre per year *(4)*. Ralston and Lemmien arrived at similar results and concluded that an investment in pruning should yield 3 to 8 percent compound interest over 60 years *(26)*.

Instead of more examples, each of which is based on local costs and conditions, here is a formula that allows you to figure your own potential profit.

Shaw and Staebler *(27)* make the calculations very simple:

Profit = (Volume of clear wood produced $\times$ difference in value between clear wood and knotty wood) — (pruning costs $\times$ compound interest)

Assuming that we do all we can to hold down cost of pruning, the next best way to insure a profit is to get the fastest growth rate possible. This means, of course, that pruning will pay the most on the best sites — and possibly will not pay at all on poor sites, especially if high interest rate is used *(13)*. But mostly it means that pruning must be coordinated with thinning to keep pruned trees growing as fast as possible.

SUMMARY

From a review of the literature we are convinced that:

- White pine plantations in the Central States should be pruned if the planting is to show a maximum profit.
- It is necessary to prune only potential crop trees plus perhaps 30 percent more to provide a safety factor.
- Pruning should begin early, while branches are less than 2 inches in diameter, but no pruning should be attempted until some of the trees are expressing dominance.
- A handsaw and ladder are the most efficient equipment to use.
- Wounding the shoulder at the base of the branch promotes healing, but the bark on the trunk must not be torn.
- Although winter pruning is least likely to damage trees, the job can be done in any season.
- At least 25 percent of the length of the live crown can be pruned without risking loss of height growth. In closed stands, up to 50 percent of the total height of the tree can be removed.
- Pruning should be closely coordinated with thinning to insure good diameter growth of the pruned trees.
- Spacing white pine plantations at 7 by 7 or 8 by 8 feet promotes earlier crown closure and smaller branches, but since the trees do not self-prune well no matter how closely spaced, a 9- by 9-foot spacing may be more appropriate. Wider spacing not only requires less labor and planting stock but also postpones the need for thinning.
- Pruning will probably not pay on poor sites where diameter growth is slow.

LITERATURE CITED

(1) Adams, W. R., and Schneller, M. R.
1939. SOME PHYSIOLOGICAL RESPONSES TO CLOSE PRUNING OF NORTHERN WHITE PINE. Vt. Agr. Expt. Sta. Bul. 444, 26 pp., illus.

(2) Barrett, Leonard I., and Downs, Albert A.
1943. GROWTH RESPONSE OF WHITE PINE IN THE SOUTHERN APPALACHIANS TO GREEN PRUNING. Jour. Forestry 41(7): 507-510, illus.

(3) Bull, Henry
1943. PRUNING PRACTICES IN OPEN-GROWTH LONGLEAF PINE IN RELATION TO GROWTH. Jour. Forestry 41(1): 174-179, illus.

(4) Campbell, Robert A.
1956. PROFITS FROM PRUNING APPALACHIAN WHITE PINE. U.S. Dept. Agr., Forest Serv., Southeast. Forest Expt. Sta. Paper 65, 9 pp., illus.

(5) Cline, Albert C., and Fletcher, E. D.
1928. PRUNING FOR PROFIT AS APPLIED TO EASTERN WHITE PINE. Harvard Forest and Mass. Forestry Assoc. 23 pp., illus.

(6) Cook, David B.
1951. JUSTIFICATION FOR FOREST PRUNING IN THE NORTHEAST. Jour. Forestry 49(7): 487-489.

(7) Curtis, J. D.
1936. A METHOD OF PRUNING DEAD BRANCHES. Forestry Chron. 12: 291-299.

(8) _____
1937. HISTORICAL REVIEW OF ARTIFICIAL FOREST PRUNING. Forestry Chron. 13: 380-395.

(9) Davis, Grant
1958. GROWTH OF WHITE PINE AND RED SPRUCE TREES AFTER PRUNING. U.S. Dept. Agr., Forest Serv., Northeast. Forest Expt. Sta., Res. Note 83, 2 pp.

(10) _____
1958. PROFITS FROM PRUNING PONDEROSA PINE IN RELATION TO PRUNING DIAMETER. Jour. Forestry 56(12): 905-908.

(11) Doolittle, Warren T.
1954. WEEVILS ATTRACTED TO BUD-PRUNED WHITE PINE. U.S. Dept. Agr., Forest Serv., Southeast. Forest Expt. Sta. Res. Note 63, 2 pp.

(12) Downs, Albert A.
1944. GROWTH OF PRUNED EASTERN WHITE PINE. Jour. Forestry 42(8): 598.
(13) Engle, LaMont G.
1953. SOME COST ASPECTS OF PRUNING RED PINE. Mich. Acad. Sci., Arts, and Letters Papers 39: 151-157.
(14) Fox, Howard W.
1957. BUD-PRUNING RED PINE AND EASTERN WHITE PINE IN NORTHERN ILLINOIS. Jour. Forestry 55(5): 359-363.
(15) Frothingham, E. H.
1942. TWENTY YEARS RESULTS OF PLANTATION THINNING AT BILTMORE, N. C. Jour. Forestry 40(6): 444-452, illus.
(16) Hawley, Ralph C., and Clapp, Robert T.
1935. ARTIFICIAL PRUNING IN CONIFEROUS PLANTATIONS. Yale Univ. School Forestry Bul. 39, 36 pp., illus.
(17) _____ and _____
1942. GROWING OF WHITE PINE ON THE YALE FOREST NEAR KEENE, N. H. Yale Univ. School Forestry Bul. 48, 44 pp., illus.
(18) _____ and Lutz, Harold J.
1943. ESTABLISHMENT, DEVELOPMENT, AND MANAGEMENT OF CONIFER PLANTATIONS IN THE ELI WHITNEY FOREST, NEW HAVEN, CONNECTICUT. Yale School Forestry Bul. 53, 81 pp., illus.
(19) Lane, Richard D.
1960. MANAGING YOUNG STANDS FOR QUALITY PRODUCTION. In: What's known about managing eastern white pine. U.S. Dept. Agr. Prod. Res. Rpt. 38: 45-55.
(20) Logan, K. T.
1959. SOME EFFECTS OF PRUNING ON WHITE PINE SEEDLINGS. Forestry Chron. 35: 109-111, illus.
(21) McCabe, Robert A., and Labisky, Ronald F.
1959. LEADER FORKING OF RED AND WHITE PINES IN PLANTATIONS. Jour. Forestry 57(1): 94-97, illus.
(22) Mollenhauer, Wm., Jr.
1938. TOOLS AND METHODS IN AN EXPERIMENTAL PRUNING OF WHITE PINE. Jour. Forestry 36(6): 588-599, illus.
(23) Paul, Benson H.
1938. KNOTS IN SECOND-GROWTH PINE AND THE DESIRABILITY OF PRUNING. U.S. Dept. Agr. Misc. Pub. 307, 35 pp., illus.
(24) _____
1946. TREE PRUNING BY ANNUAL REMOVAL OF LATERAL BUDS. Jour. Forestry 44(7): 499-501, illus.

(25) Ralston, R. A.
1953. TIME REQUIRED TO PRUNE RED PINE TO VARIOUS HEIGHTS. U.S. Dept. Agr., Forest Service, Lake States Forest Expt. Sta. Tech. Note 391, 1 p.
(26) _____ and Lemmien, Walter
1956. PRUNING PINE PLANTATIONS IN MICHIGAN. Mich. State Univ. Agr. Expt. Sta., Circ. Bul. 221, 28 pp., illus.
(27) Shaw, Elmer W., and Staebler, George R.
1950. FINANCIAL ASPECTS OF PRUNING. U.S. Dept. Agr., Forest Serv., Pacific Northwest Forest & Range Expt. Sta., 45 pp., illus.
(28) Slabaugh, Paul E.
1957. DO PRUNED RED PINE TREES REMAIN DOMINANT? U.S. Dept. Agr., Forest Serv., Lake States Forest Expt. Sta. Tech. Note 476, 2 pp., illus.
(29) Smith, J. H. G.
1954. THE ECONOMICS OF PRUNING. Forestry Chron. 30: 197-214, illus.
(30) U.S. Dept. Agriculture, Forest Service, Southeastern Forest Experiment Station.
1961. ANNUAL REPORT. 1960: 33-34, illus.
(31) Williamson, P.
1939. PRUNING OF TIMBER PLANTATIONS IN NEW ZEALAND. Empire Forestry Jour. 18: 253-258.

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